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Abstract

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The Emerging Ethics of Humancentric GPS Tracking and Monitoring

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Abstract

The Global Positioning System (GPS) is increasingly being adopted by private and public enterprise to track and monitor humans for location-based services (LBS). Some of these applications include personal locators for children, the elderly or those suffering from Alzheimer's or memory loss, and the monitoring of parolees for law enforcement, security or personal protection purposes. The continual miniaturization of the GPS chipset means that receivers can take the form of wristwatches, mini mobiles and bracelets, with the ability to pinpoint the longitude and latitude of a subject 24/7/365. This paper employs usability context analyses to draw out the emerging ethical concerns facing current humancentric GPS applications. The outcome of the study is the classification of current state GPS applications into the contexts of control, convenience, and care; and a preliminary ethical framework for considering the viability of GPS location-based services emphasizing privacy, accuracy, property and accessibility.

1. Introduction

GPS has the ability to calculate the position, time, and velocity of any GPS receiver. It does so using a process of triangulation, which works on the premise that you can find any position if the distance from three other locations is also known. Originally conceived by the U.S. Air Force for military purposes in the 1960s, it was commercially released in 1995. In 2000, selective availability was turned off, providing consumers the same level of accuracy as the U.S. military. Since that time, mobile business applications based on GPS and cellular network technologies have proliferated. The rate of innovation has been high, and the level of adoption has been steadily increasing, showing a great deal of promise for the small start-up companies which are targeting GPS solutions at families, enterprises, and security-related government initiatives. This paper is significant because in the not-to-distant future, mobile devices will have GPS chipsets on board. Yet, the

growth in the number of commercial offerings- while approved by government regulatory bodies- have not been faced with the commensurate ethical discourse which includes legalities and ownership. The aim of this paper is to explore current commercial services based on GPS technology, with a view to identifying emerging ethical concerns and developing an ethical framework.

2. Background

The concept of tracking and monitoring using GPS technologies is far from novel [1]. Numerous studies and experiments have investigated the potential of GPS to record a person's movements [2,3]. However, very few studies have attempted to explore the ethical problems of GPS tracking. The question of ethics in precise location services has been gathering traction within the research community, much of this provoked by Wal-Mart's announcement to implement radio-frequency identification (RFID) for itemized inventory tracking using the EPCglobal standard. More recently a whole issue of the *Communications of the ACM* was dedicated to RFID privacy and security concerns, while other location technologies were largely ignored. The work of Dobson and Fischer [4], Garfinkel et al. [5], Michael and Michael [6], Perusco and Michael [7], Kaupins and Minch [8], Perakslis and Wolk [9] and Stajano [10] have all indicated the need for a deeper understanding of ethics in location services. In addition the foreseeable power of GPS working in tandem with RFID and wireless local area networks (WLANs), will bring with it a new suite of pressing concerns.

2.1. Unanswered questions

Many questions remain unanswered. Who is liable for providing an incorrect geographic reference location for an emergency services call? Does a private enterprise require the consent of an individual subscriber to track a vehicle that has been rented and is mounted with a GPS receiver? Does a government agency or the police force have the right to location information for a given subscriber when they suspect

illegal activity? Do refugees or illegal immigrants have the right to refuse a government-imposed tracking device? Is the 24/7/365 monitoring of a parolee's location information ethical? What rights does a mentally ill person have to their location data and does a caregiver have the right to impose certain geographic constraints on that subscriber? And how do caregiver relationships differ from guardian/parent-to-child, or husband-to-wife contexts? And what of employer work-related location monitoring of employees? Who owns location data- the individual subscriber, the service provider, or a third party that stores the information? The answers to these questions are complex and highlight the urgent need for the development of an ethical framework and other industry guidelines.

3. Usability context analyses and ethics

Ethics is defined as “[a] system of moral principles, by which human actions and proposals may be judged good or bad or right or wrong” (Macquarie Dictionary). Moral is concerned with “right conduct or the distinction between right or wrong.” This study is aimed at exploring whether the real-time tracking and monitoring of people is morally right or wrong. It is an attempt to formulate an ethical framework by considering principles of moral behavior- something that “has always been a necessary feature of human cultures” [11,12]. The conceptual approach used toward the building of an ethical framework is based on four main aspects: principles, purpose, morality and justice (Table 1).

Table 1. Ethics-based conceptual approach

Human Purpose			
Principles	▪ Participants	▪ Systems	Morality
	▪ People Concerns	▪ Expected Behavior	
	▪ Cultural Values	▪ Religious Beliefs	
	▪ Interactions	▪ Enforce Principles	
	▪ Rules & Norms	▪ Fairness	
	▪ Structures	▪ Personal Benefit	
	▪ Governing Body	▪ Personal Harms	
Justice			

When one conducts a usability context analysis, they are not focused on a traditional case study but on a specific product innovation area. The unit of analysis is thus any interactive system or device which supports a user's task. This approach has been used successfully in the past to study controversial chip implant applications [13]. Three usability contexts will be

analyzed- care, control and convenience. Each context will focus on uses of GPS tracking and monitoring applications. There is synergy between a usability context analysis methodology and an ethics-based conceptual approach, as one looks at the use, and the other at the implications of the use value.

4. Control

Most ethical issues are connected to the control aspect of GPS tracking, as it imposes an intrusive method of supervision. For the purposes of control GPS has been used for law enforcement, parolees and sex offenders, suspected terrorists and employee monitoring.

4.1. Law enforcement

U.S. law specifies that a court can issue a warrant for the installation of a mobile “tracking device” if a person is suspected of committing a crime [14]. See also House Bill 115 currently being deliberated in the U.S. The term “tracking device” covers a broad spectrum of technologies but the popularity and simplicity of GPS makes it an obvious choice. Gabriel Technologies is one company which is seeking to be the supplier of choice for the federal and homeland security markets [15]. GPSs are even being used to track gang members in U.S. cities, strapped to parolees [16].

There are documented cases in the U.S. of police discreetly planting GPS devices on suspected criminals. The William Jackson case was the first to rule that placing a GPS device on a person or their vehicle does not require a warrant as it is the same as following them around [17]. In 2000, Jackson was found guilty of murdering his daughter after the GPS device placed on his truck found that he had returned to his daughter's crime scene. In another case in New York the judge ruled that police do not need a warrant to track a person on a public street stating that the defendant: “... had no expectation of privacy in the whereabouts of his vehicle on a public roadway” [18]. In San Francisco, Scott Peterson had a GPS tracking device placed on his car after being suspected of murdering his pregnant wife in 2002 [19]. His suspicious behavior led to a legal trial involving much speculation over the use of the GPS antenna (even though police had a warrant), and the accuracy of the collected data [20]. However, the judge ruled that the technology was “generally accepted and fundamentally valid” [21].

4.2. Parolees and sex offenders

Today many parolees are fitted with a small tamper-proof GPS tracker worn as a bracelet or anklet. The ankle device is in the shape of a rigid plastic ring, accompanied by a small tracking box that can fit in a pocket [22]. Companies such as iSECUREtrac, design GPS monitoring systems to track parolees and sex offenders ensuring they do not commit any crimes, alert authorities if they enter certain locations, (e.g. schools, parks), and prevent them from leaving their homes, if that is prohibited [23]. Some GPS units can also offer the added capability of knowing how much alcohol a person has consumed by measuring perspiration levels every hour. Parolee and pedophile tracking is widespread in the United States with an estimated 120,000 tracked parolees in 28 states [24]. However, there are over 50,000 convicted sex offenders in the US that are not tracked at all [25].

Australian states have been trialing GPS systems and there are proposed schemes for NSW, Western Australia and Victoria [26]. In NSW there are 1,900 offenders on the Child Protection Register but officials say it is too costly and difficult to track all of them [27]. Queensland's corrective services minister, Judy Spence, reviewed a New Zealand trial and found that for the GPS scheme to be cost-effective in Australia, there would need to be quite a lot more prisoners. It is interesting to note, that the question of ethics was not addressed: "the cost of monitoring someone using GPS technology [is] about \$52,000 AUD a year- just \$1,000 cheaper than keeping them in prison [28]. However, in Florida (USA), the estimated cost of placing tracking devices on all sex offenders is \$8 million USD per annum, compared with what it would have cost behind bars at \$56 million USD per annum [25]. Accounting for each person individually would cost about \$8 daily in their own home, compared to \$100 if they were physically in prison [24]. One disadvantage of the parolee tracking process is its labor intensive nature. A U.S. parolee officer in Georgia who monitors the movements of 17 parolees has said: "...the amount of information is overwhelming... I could easily spend an hour every morning on each offender to go over the information that's there. For some of them, it's necessary. For some of them, it's not" [29]. The amount of data generated has some advantages, such as in the event that parolees are falsely accused of committing crimes at particular locations and evidence suggests otherwise. The message from the police is clear, "[w]e know where you are, and we are watching" [30].

4.3. Suspected terrorists

A number of national laws stipulate the use of a tracking device affixed to any person suspected of "activities prejudicial to security" (e.g. ASIO Act 1979). Previously, the maximum period of time a suspected terrorist could be tracked was 6 months, however, during the Council of Australian Government (COAG) meeting on counter-terrorism it was planned to increase this period to 12 months [31].

4.4. Employee monitoring

Employees that are tracked using GPS usually travel in vehicles over long distances. Tracked workers include couriers, and bus and truck drivers. The motivation for tracking employees is linked to improving company productivity. Automated Waste Disposal Incorporated uses GPS to ensure their truck drivers do not speed and are on track to meet their delivery schedule. The company imposed GPS tracking on its employees to reduce overtime and labor costs. After implementing the GPS tracking system the number of overtime hours dropped from 300 to 70 hours on average per week [32].

5. Convenience

Although GPS tracking may not be widely used for the purposes of convenience today, there are a number of commercial uses. For example, Satellite Security Systems (S3), offer vehicle tracking services to a variety of customers, including parents and suspicious spouses [33]. Clients carry a GPS device with them which transmits location data to S3 computers for further analysis. S3 tracks so many vehicles that even homeland security officials sometimes turn to them for support. GPS systems are also becoming important in delivering key business processes such as real-time sales force automation. Norwich Union uses GPS to track their 18 to 21 year old customers, charging their car insurance premiums based on the time of day they drive. The company induces a tariff at peak times when there is a greater chance of having an accident [34]. Companies like Disney are riding on their family brand, targeting up to 30 million children that they classify as "tweens" (8-12 year olds), with location-based family-centric services [35]. But this idea is not new, Japanese school children have for some years been tracked by their parents, wearing transmitters in their school backpacks, uniforms, or shoes [36]. BuddyFinder systems have also been around for some time, allowing friends and family to catch up based on

their whereabouts. On another level, there are even golf GPS devices which display the layout of each hole and player locations on the course [37].

6. Care

GPS satellite tracking can assist people who are responsible for the health and wellbeing of others. Two such applications include GPS for tracking dementia sufferers, and parents tracking their children.

6.1. Dementia wandering

Dementia is a symptom of a number of diseases. However, the most common forms are Alzheimer's disease, vascular dementia and dementia with Lewy bodies [38]. It currently affects five per cent of people aged over 65 years and twenty per cent of people aged over 80 years. Dementia becomes a serious problem when a patient begins to wander. Due to his/her mental state a dementia sufferer may get lost easily and may even be injured or killed [39]. Since it is difficult to keep constant watch over a dementia sufferer, a caregiver can employ a variety of assistive technologies which notify family members automatically by phone or email if problems arise [3]. Proponents of this application emphasize that the technology grants dementia sufferers more independence and freedom, allowing them a better quality of life [40].

6.2. Parents tracking children

There are a number of GPS products available today which allow parents to track their children. One of the more popular products is Wherifone created by WherifyWireless. The device is about the size of a credit card and has a feature which alerts emergency services. Previously, the company offered a wristwatch tracker but discontinued production because customers wanted to be able to call their children [41]. Users can find the location of their child by logging onto the company website and viewing data on a map. Gilson's AlwaysFind GPS trackers are an alternative [42]. Another GPS tracking system provided by TAA GPS, supports *The Teen Arrive Alive* program in the U.S., dedicated to addressing teenager driving safety. Parents can find the location of their teenage child, for \$19.99 USD a month by using the Internet or calling the locator hotline [43]. Locations are updated every two minutes so parents can keep a constant eye on their child's activities. Further on the theme of driving, the application Ezitrack allows parents in Australia to immobilize a car while it is moving. Even though the

device gives a ninety second warning before the car shuts down, officials are still concerned saying it is dangerous, causes inconvenience, and "puts (policing) in the hands of the individual" [44]. A South Australian primary school is also using a GPS tracking system on their school bus, to monitor the speed and keep track of where children get off the bus [45].

7. Towards an ethical framework

In each usability context analysis, several GPS tracking applications were presented, raising questions about the potential ethical implications of the technology. Yet the "acceptable use" of GPS is currently undefined. Can information generated by a receiver, be treated the same as just any other piece of information? Can data generated by a GPS for one purpose, be used for another? For example, can vehicle tracking be used to track an employee, and to convict the driver of speeding?

Table 2. Ethical framework

Privacy	Accuracy
<ul style="list-style-type: none"> • What location specific information should an individual be required to reveal to others? • What kind of surveillance can a parent use on a child? • What kind of surveillance can employers use on employees? • Do police need a warrant to track a suspected criminal? 	<ul style="list-style-type: none"> • Who is responsible for the authenticity, fidelity and accuracy of information collected? • Who is to be held accountable for errors in information, and how is the injured party compensated? • Is GPS an appropriate tracking technology for dementia wandering? • How can we ensure that errors in databases, data transmissions and data processing are accidental and not intentional?
Property	Accessibility
<ul style="list-style-type: none"> • Who owns information? • What are the just and fair prices for exchange? 	<ul style="list-style-type: none"> • Who is allowed to access GPS tracking services? • How much should be charged for permitting accessibility to information? • Who will be provided with equipment needed for accessing information? • Is the tracking of parolees and sex offenders justified?

The most significant ethical issue facing GPS tracking is that of privacy (Table 2). It can be claimed that products that have the ability to track their subjects are automatically impinging the rights of the individual, even if they themselves have elected to carry the device. Legal jurisdictional issues also apply, as do acts which often seemingly contradict one another. For instance, there is precedence that indicates that a person can be found guilty of a crime based on GPS generated information [46]. In one such case, the judge ruled that there was “no Fourth Amendment implications in the use of the GPS device.” A framework has been devised to encapsulate the ethical issues related to GPS tracking and monitoring. This framework is based on the information technology (IT) ethical issues framework created by Mason [47], and later updated by Turban [48]. The four main ethical issues are categorized into privacy, accuracy, property and accessibility.

7.1. Privacy

The greatest concern of GPS tracking is the amount of information that can be deduced from the analysis of a person’s movements.

7.1.1. What location-specific information should an individual require to reveal to others? In many cases a person’s location does not need to be known unless he/she does something unexpected. Parents only need to know if their child is not at school when they should be or is speeding in a vehicle. Similarly, caregivers should only be notified if a dementia patient is wandering, and parole officers only need to know if a parolee ventures outside his/her home zone. Employers too can be alerted when one of their vehicles has made an unnecessary detour.

7.1.2. What kind of surveillance can a parent use on a child? Using a GPS device to track a child’s location is becoming more and more popular. If a child is lost or kidnapped he or she has a better chance of being found. But does the child have a right to determine whether or not they are to be tracked, and until what age or length of time? [49] Another question is how children actually feel about being tracked? [50] Are parents replacing trust with technology, [41] and developing an unhealthy relationship with their children? [51] Christy Buchanan, an associate professor of psychology believes that: “[p]arents shouldn’t fool themselves into thinking that they can keep their kids from making mistakes, which is a part of growing up and learning” [52]. Simon Davies of Privacy International believes

parents may even become obsessed with tracking their children [51]. On the other hand, parents who have experienced the loss of a child, see GPS as a life-saving technology, especially those who have lost children to drink-driving accidents. These parents point out that tracking is for safety, not for spying.

7.1.3. What kind of surveillance can employers use on employees? Employers usually track their employees to reduce costs, especially labor costs and costs related to unnecessary product shrinkage. In this context, employers attempt to protect their business interests, and employees attempt to protect their privacy? [53] The two positions are in contrast, as the power is obviously in the hands of the employer. Some workers however have objected to the technology due to privacy concerns [54]. Galen Monroe, a truck driver from Chicago USA, voices his concern: “[t]hese systems could be used to unfairly discipline drivers, for counting every minute that they might or might not be on or off duty and holding that against them” [32]. Lewis Maltby, president of the National Workrights Institute in New Jersey, said that the exchange of privacy for security would affect employee morale and that the next steps would probably be implants [55]. Managers, on the other hand, are more concerned that workers are doing what they are paid to do. Yet this is a shocking development when one considers that there are few, if any, laws governing workplace surveillance in countries like the U.S. and Australia [56].

7.1.4. Do police need a warrant to track a suspected criminal or terrorist? Several cases have ruled that tracking a person with a GPS device is the same as following them on the street. However, GPS tracking is much more pervasive. First, a person is usually more aware of a person following them, than if a small tracking device were attached to their vehicle. Additionally, a GPS tracker can find a person’s location anywhere at anytime even when trailing is not possible. Furthermore, since a tracked person’s location is digitized it can be instantly analyzed to make inferences, in ways that simple observations cannot [57]. If the issuing of warrants is not compulsory there will be no barriers for police or security personnel to place tracking devices on any individual. Warrants are essential to ensure GPS tracking devices are used justly and ethically.

7.2. Accuracy

GPS can give error readings in particular conditions. Dense forest, tall buildings, cloud cover and moisture

produce inaccuracies in readings but these are considered negligible when compared to the potential for inaccuracies in resultant information processing.

7.2.1. Who is responsible for the authenticity, fidelity and accuracy of information collected? In the event of GPS failure or enforced shut down by the U.S. government, companies whose mission-critical applications rely on GPS technology would incur heavy losses. The U.S. government has already released plans to shut down parts of the network in a “national crisis” to prevent terrorists from using the network [58]. Consider the implications for those organizations and customers that have become reliant on the technology, for example, criminals serving their sentence from home. And who is responsible for accuracy? The U.S. government created the system but they are under no obligation to ensure accuracy. Another concern is that sixteen of the twenty-eight GPS satellites currently in orbit are beyond their design life and are likely to fail in the near future [59]. At least two satellites are failing each year and launches of new satellites are barely keeping up. This poses problems for the users of the GPS system in the longer term which is why the more accurate European Galileo initiative is critical.

7.2.2. Who is to be held accountable for errors in information, and how is the injured party compensated? Private companies who offer GPS tracking services avoid liability by introducing product descriptions, warranties and disclaimers [60]. In California several rental car companies were wrongly fining customers for breaking their rental agreement for allegedly leaving the state. Customers were asked to pay \$3000 USD for something they did not do. As a result California became the first U.S. state to prohibit the use of GPS receivers by car rental companies to track their customers [33].

7.2.3. Is GPS an appropriate tracking technology for dementia wandering? The Project Life Saver Organisation helps locate and return wandering dementia sufferers. They believe that GPS is not suitable for tracking persons with dementia, recognizing that GPS lacks four fundamental attributes of an assistive technology: reliability, responsiveness, practicality and affordability [39].

7.2.4. How can we ensure that errors in databases, data transmissions and data processing are accidental and not intentional? Software used to store tracking data makes it possible to edit data points in order to create false evidence. Effectively a person

can be accused of a crime he or she did not commit. For this reason it is imperative that extensive validation checks are enforced to ensure data has not been tampered. There is also the concern with the intentional and non-intentional jamming of GPS signals. Safeguards and laws restricting GPS jamming need to be advocated.

7.3. Property

7.3.1. Who owns the information? The U.S. government owns the physical satellite system but who owns the information once it is collected? If a company collects and stores location information on a person who commits a crime, are they obliged to hand it over to the police?

7.3.2. What are the just and fair prices for exchange? It is theoretically free to access GPS, as long as you have a receiver. Free service however, does not equate to commercial satisfaction. GPS-based voice service providers incur a cost for ‘priority access’, and therefore pass this cost onto their subscribers.

7.4. Accessibility

7.4.1. Who is allowed to use the GPS service? One of the objectives set out by the GPS policy is the provision of worldwide “positioning, navigation, and timing services” [61]. However, the GPS policy also indicates that the GPS system can be shut down in certain areas “under only the most remarkable circumstances,” like in the event of a terrorist attack [62].

7.4.2. How much should be charged for permitting accessibility to information? US policy proclaims that the GPS service is and will continue to be “free of direct user fees” [62]. However, private companies are billing customers to use services [63]. Costs may include payment for equipment and data transmission among other fees. There is also the possibility that information can be accessed illegally by a third party for sinister purposes.

7.4.3. Who will be provided with equipment needed for accessing information? Parolee tracking is more cost-effective than detainment but it is impossible to have all parolees and sex offenders tracked. So who will be tracked and who will not? In previous cases less aggressive criminals have GPS tracking devices attached first. Where radio tag tracking methods have

been used, parolees have had to pay for their own tracking devices [24].

Table 3. The ethical possibilities

Application	Reasons for being ethical	Reasons for being unethical
Tracking dementia wandering	<ul style="list-style-type: none"> • Wandering patients are able to be located before they are harmed. • Provides a sense of security to caregivers. 	<ul style="list-style-type: none"> • Technology may not be suited to dementia wanderers as it can be unreliable, unresponsive, impractical and unaffordable.
Parents tracking children	<ul style="list-style-type: none"> • Children can be located if they are lost or abducted. • Can prevent children from speeding or disobeying instructions. 	<ul style="list-style-type: none"> • Invasion of child's privacy. • The child may not have a choice.
Police placing tracking devices on suspected criminals	<ul style="list-style-type: none"> • GPS evidence may be used to rightly convict a person of a crime. 	<ul style="list-style-type: none"> • May be used without a warrant. • Location data may be modified to create a false alibi or false accusation.
Tracking parolees and sex offenders	<ul style="list-style-type: none"> • May prevent crimes from occurring. • Controls and rehabilitates parolees and sex offenders. 	<ul style="list-style-type: none"> • It could impose restrictions on parolees who are not likely to offend again.
Employers tracking employees	<ul style="list-style-type: none"> • Business owners can increase profits by ensuring employees are working efficiently. • Encourages workers to be honest. 	<ul style="list-style-type: none"> • Employees may still be tracked outside of work hours and the information used against them. • May be used to unfairly discipline drivers.
Shutting down parts of the GPS	<ul style="list-style-type: none"> • May thwart terrorist attempts. 	<ul style="list-style-type: none"> • Many businesses and individuals may be inconvenienced.

7.4.4. Is the tracking of parolees and sex offenders justified? The three most apparent reasons for parolees and sex offenders to be tracked appear to be: to save costs, deter further crimes and for controlled rehabilitation. The cost of tracking a person is much lower than incarceration. Tracking may deter some criminals from committing a similar offence but if they are tracked at length they may lose awareness of their GPS device. In examining New Zealand's Bill of

Rights (sec 21), the N.Z. Law Society (NZLS) found that authorities had the power to impose electronic monitoring on people who had already completed their sentences. NZLS argued that extended supervision equated to "two punishments for the same crime" but the government argued that the main purpose of the extended supervision was preventive not punitive [64]. Others believe that tracking parolees grants them the opportunity to spend more time with family, acting to fast-track the rehabilitation process (Table 3).

8. Conclusion

Molnar and Wagner [65] ask the definitive question "[i]s the cost of privacy and security 'worth it'?" Stajano [10] answers by reminding us that, "[t]he benefits for consumers remain largely hypothetical, while the privacy-invading threats are real." Indeed, when we add to privacy concerns the unknown long-term health impacts, the potential changes to cultural, social and political interactions, the circumvention of religious and philosophical ideals, and a potential mandatory deployment, then the disadvantages of the technology might seem almost burdensome. For the present, proponents of emerging LBS applications rebuke any negatives "under the aegis of personal and national security, enhanced working standards, reduced medical risks, protection of personal assets, and overall ease-of-living"[9]. Unless there are stringent ethical safeguards however, there is a potential for enhanced national security to come at the cost of freedom, or for enhanced working standards to devalue the importance of employee satisfaction. The innovative nature of the technology should not be cause to excuse it from the same "judicial or procedural constraints which limit the extent to which traditional surveillance technologies are permitted to infringe privacy" [56]. The aim of this present research is to understand the ethical implications of current LBS applications, with a view to emphasising the need for future innovators to ethically integrate these technologies into society.

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